FIG.1

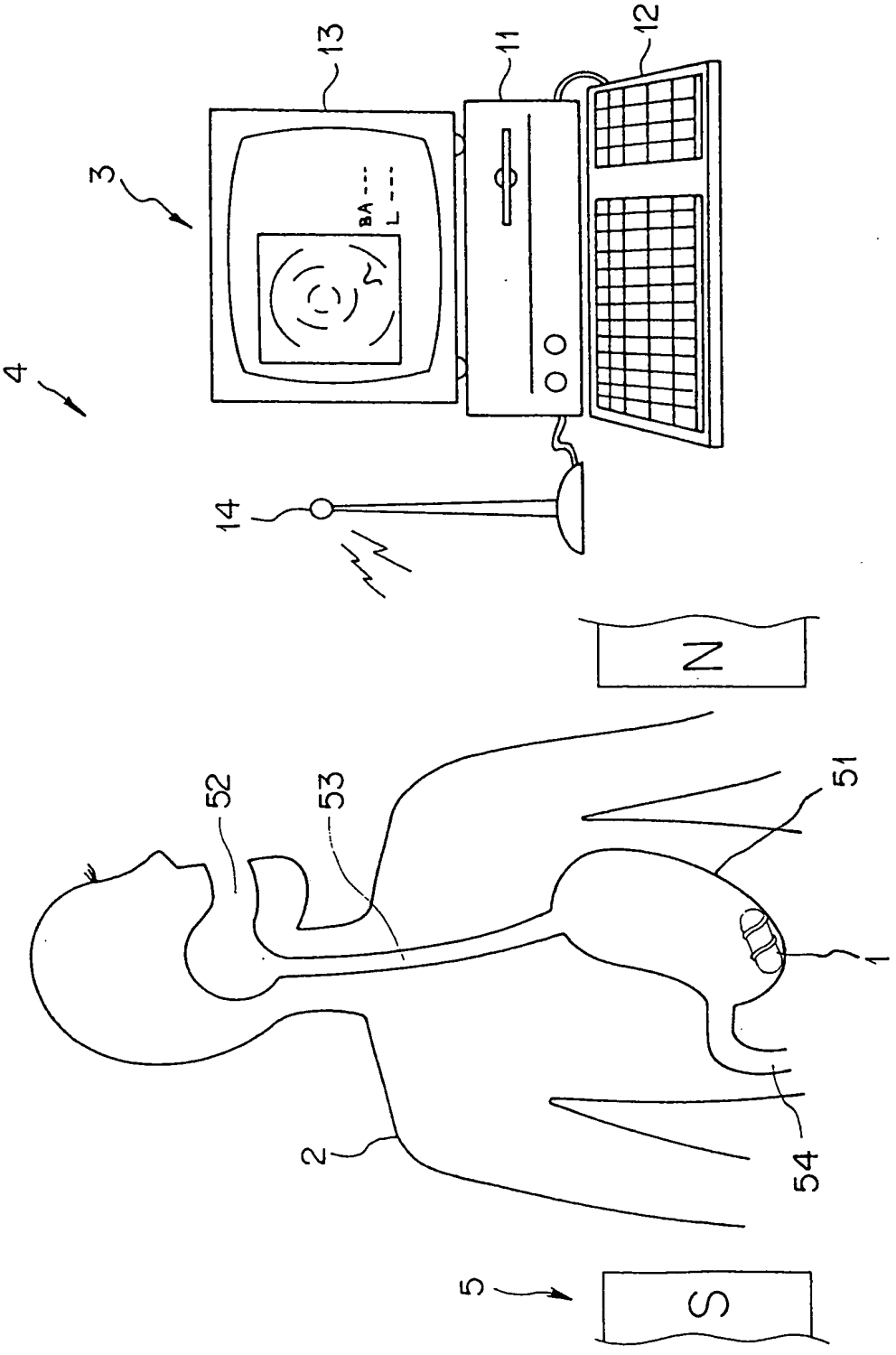


FIG.2

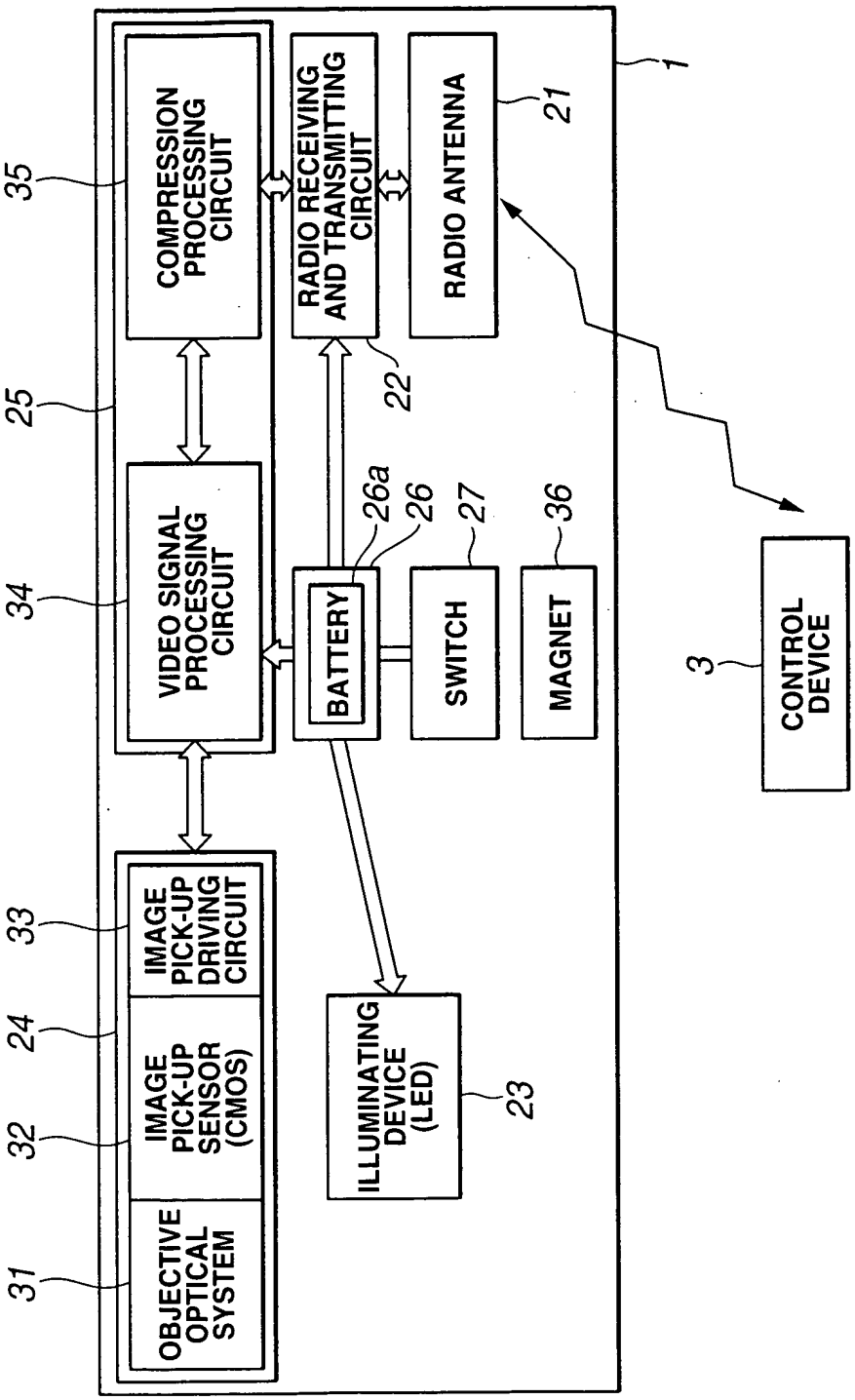

1
21
RADIO ANTENNA
22
RADIO RECEIVING AND TRANSMITTING CIRCUIT
35
COMPRESSION PROCESSING CIRCUIT
25
34
VIDEO SIGNAL PROCESSING CIRCUIT
26a
26
BATTERY
27
SWITCH
36
MAGNET
3
CONTROL DEVICE
33
IMAGE PICK-UP DRIVING CIRCUIT
24
IMAGE PICK-UP SENSOR (CMOS)
32
OBJECTIVE OPTICAL SYSTEM
31
ILLUMINATING DEVICE (LED)
23

FIG.3A

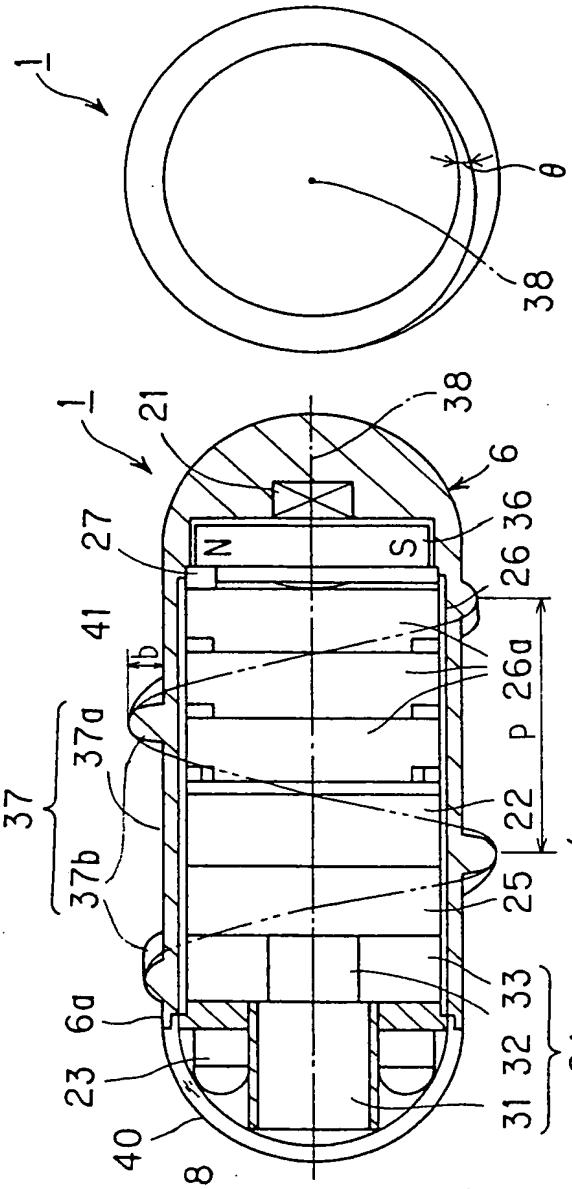


FIG.3B

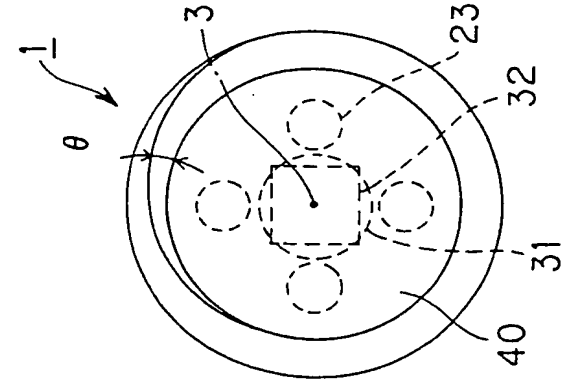


FIG.3C

FIG.3D

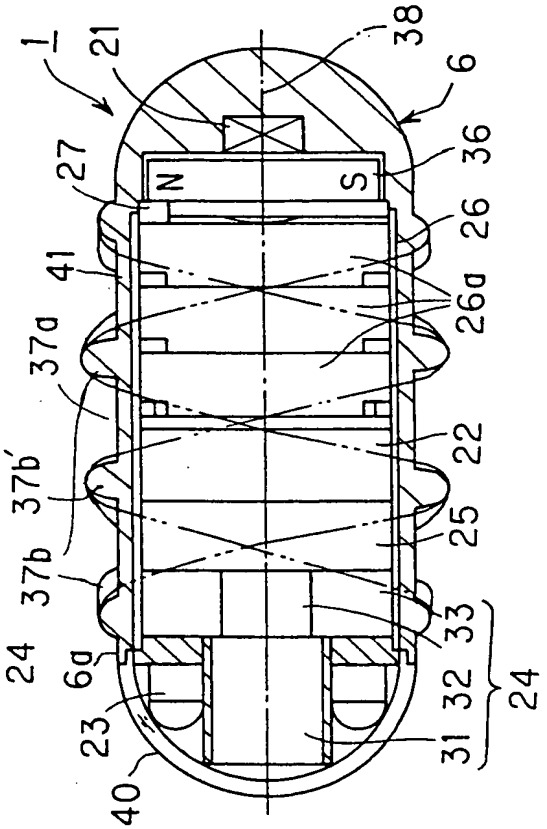
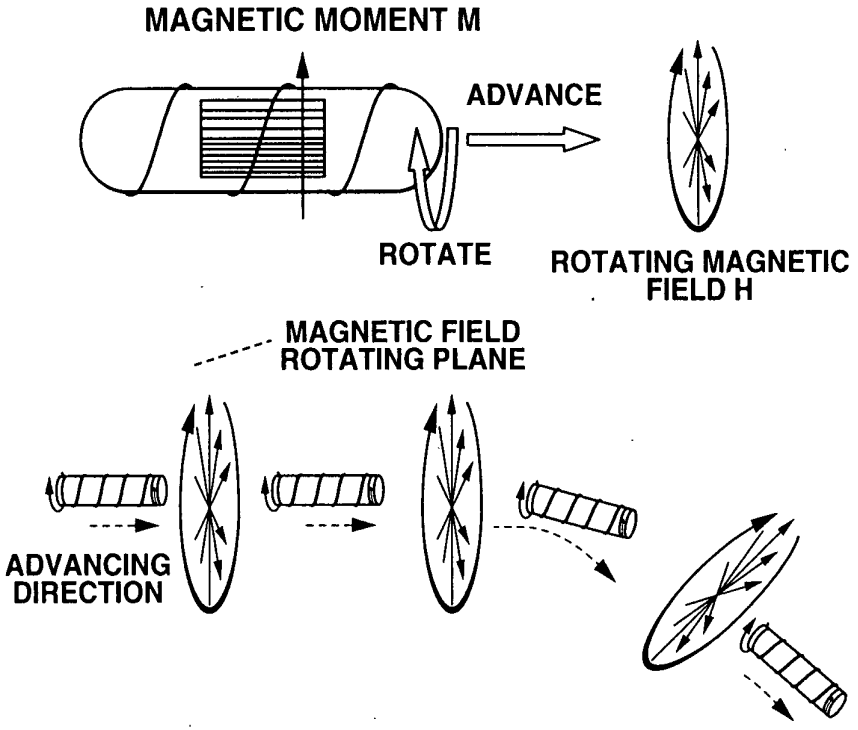


FIG.4

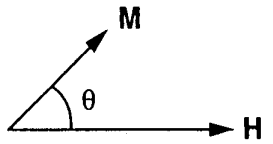
DRIVING PRINCIPLE

EXTERNALLY APPLY ROTATING MAGNETIC FIELD TO PERMANENT MAGNET
ROTATE MAGNET BY MAGNETIC TORQUE
ADVANCE BY CONVERTING ROTATING FORCE INTO THRUST WITH SPIRAL STRUCTURE
CONTROL IN ADVANCING DIRECTION BY CHANGING ROTATING PLANE OF ROTATING MAGNETIC FIELD



MAGNETIC TORQUE T

$T=M \times H$
$T=MH\sin\theta$



MAXIMUM TORQUE
AT θ OF 90°

10/541369

FIG.5A

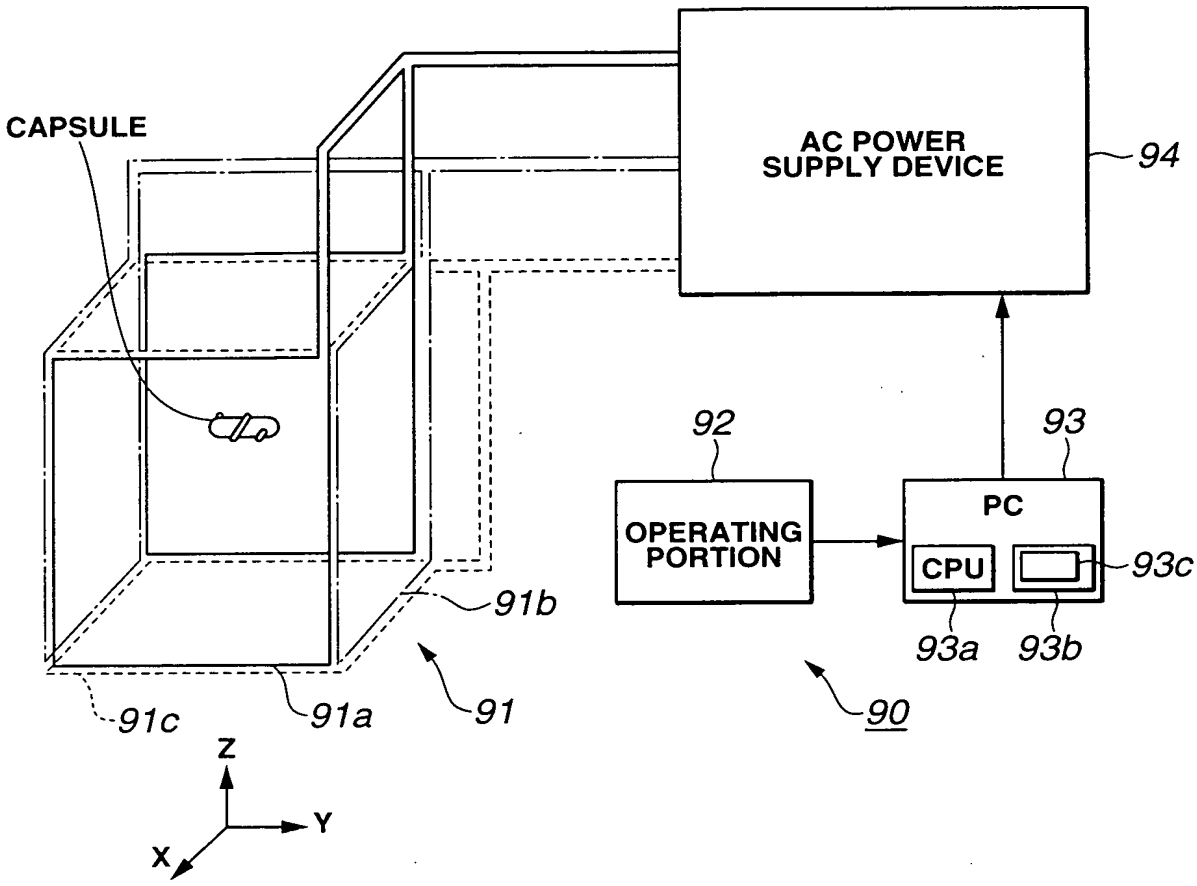

CAPSULE
AC POWER SUPPLY DEVICE
94
92
93
OPERATING PORTION
PC
CPU
93c
93a
93b
91b
91
91c
91a
90
Z
Y
X

FIG.5B

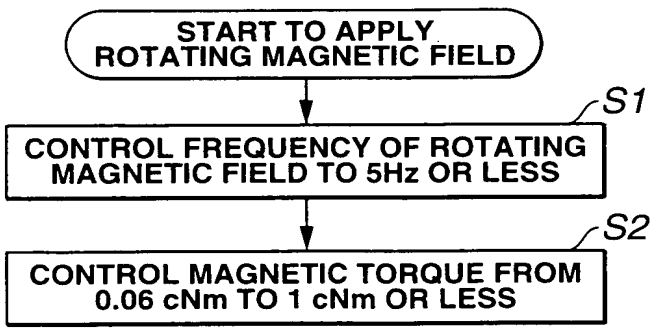
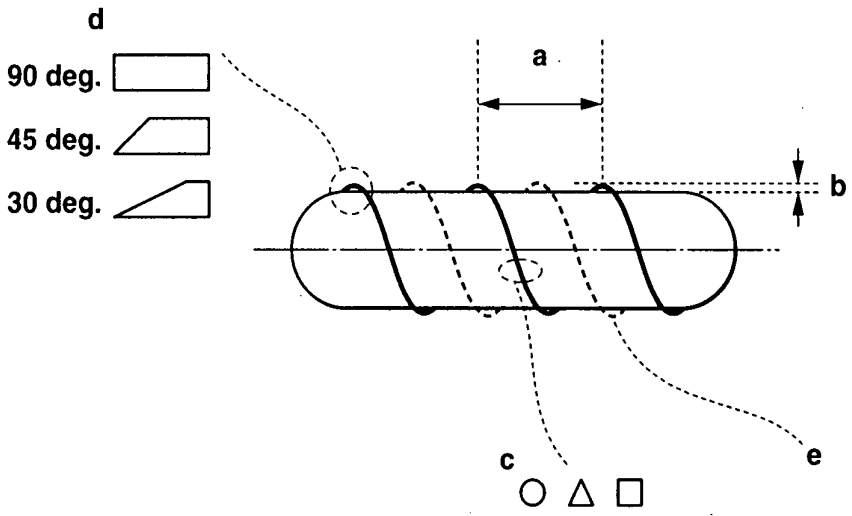

START TO APPLY ROTATING MAGNETIC FIELD
S1
CONTROL FREQUENCY OF ROTATING MAGNETIC FIELD TO 5Hz OR LESS
S2
CONTROL MAGNETIC TORQUE FROM 0.06 cNm TO 1 cNm OR LESS

FIG.6

OUTLINE OF THE EXAMINATION

CONVERT ROTATION INTO THRUST WITH SPIRAL STRUCTURE
EXAMINE SPIRAL-SHAPE INFLUENCE ON CAPSULE DRIVING CHARACTERISTIC
· ADVANCING VELOCITY
· LOAD TORQUE

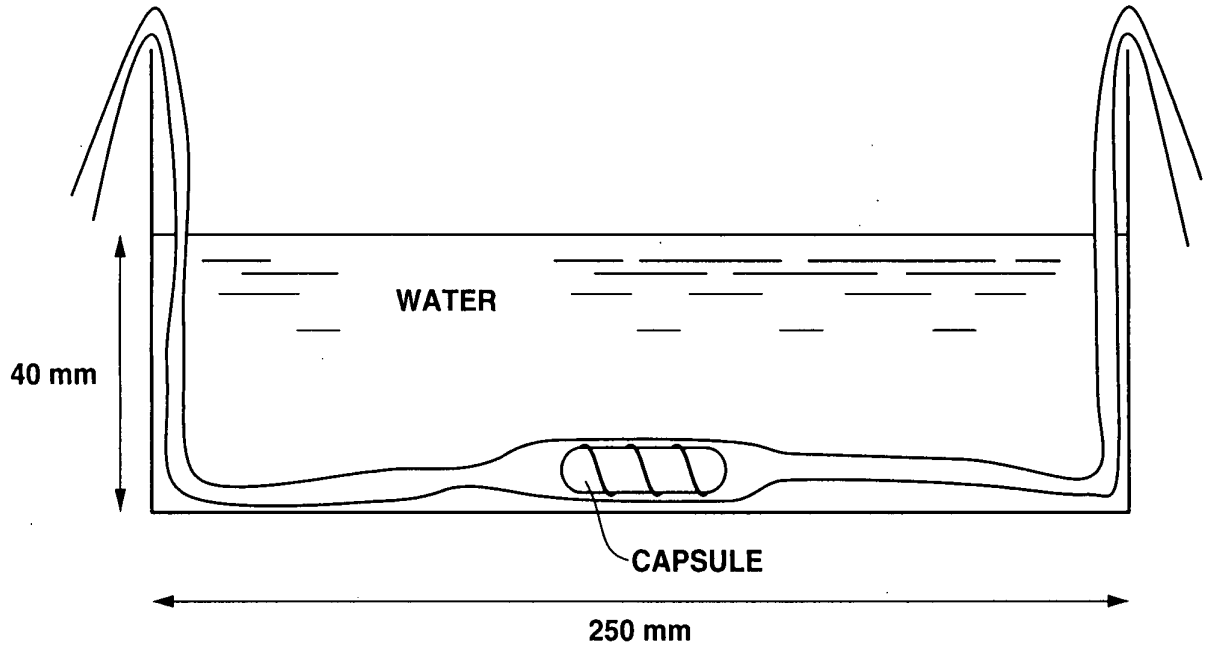


a: SPIRAL PITCH (5, 10, 15mm)
b: SPIRAL HEIGHT (1.5, 3, 4.5mm)
c: SPIRAL CROSS-SECTION
d: SPIRAL EDGE SHAPE
e: NUMBER OF SPIRAL

FIG.7

1ST EXPERIMENT -MEASUREMENT OF ADVANCING VELOCITY-

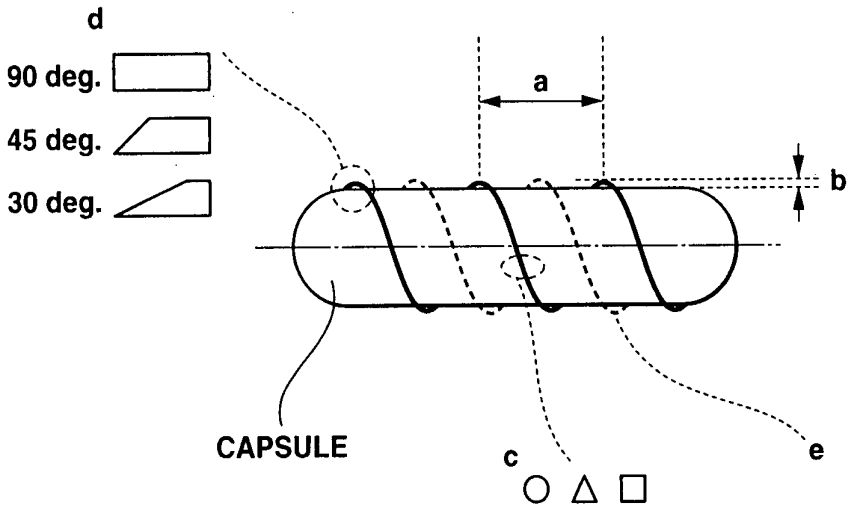
SILICON RUBBER TUBE (THICKNESS: 0.5 mm, WIDTH: 50 mm)



CAPSULE ROTATING FREQUENCY: FREQUENCY OF ROTATING MAGNETIC FIELD
FRICTION LEVEL: QUANTITY OF SILICON OIL IN TUBE
ADHESION DEGREE OF CAPSULE AND TUBE: WATER DEPTH

FIG.8

SPIRAL SHAPE USED FOR EXAMINATION



a: SPIRAL PITCH (5, 10, 15 mm)

b: SPIRAL HEIGHT (1.5, 3, 4.5 mm)

c: SPIRAL CROSS-SECTION

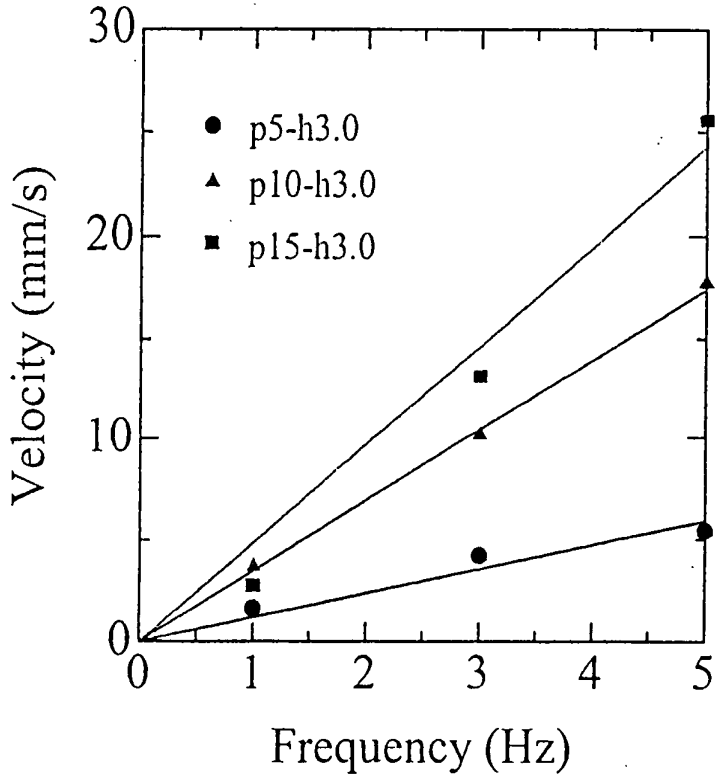
d: SPIRAL EDGE SHAPE

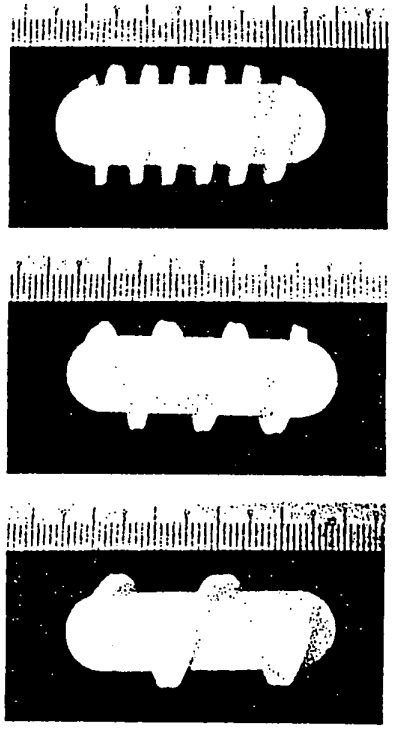
e: NUMBER OF SPIRAL

DIAMETER: 11 mm, LENGTH: 40 mm

FIG.9

EXPERIMENT RESULT SPIRAL PITCH





p5-h3

PITCH 5mm

p10-h3

PITCH 10mm

p15-h3

PITCH 15mm

FIG.10

EXPERIMENT RESULT SPIRAL HEIGHT

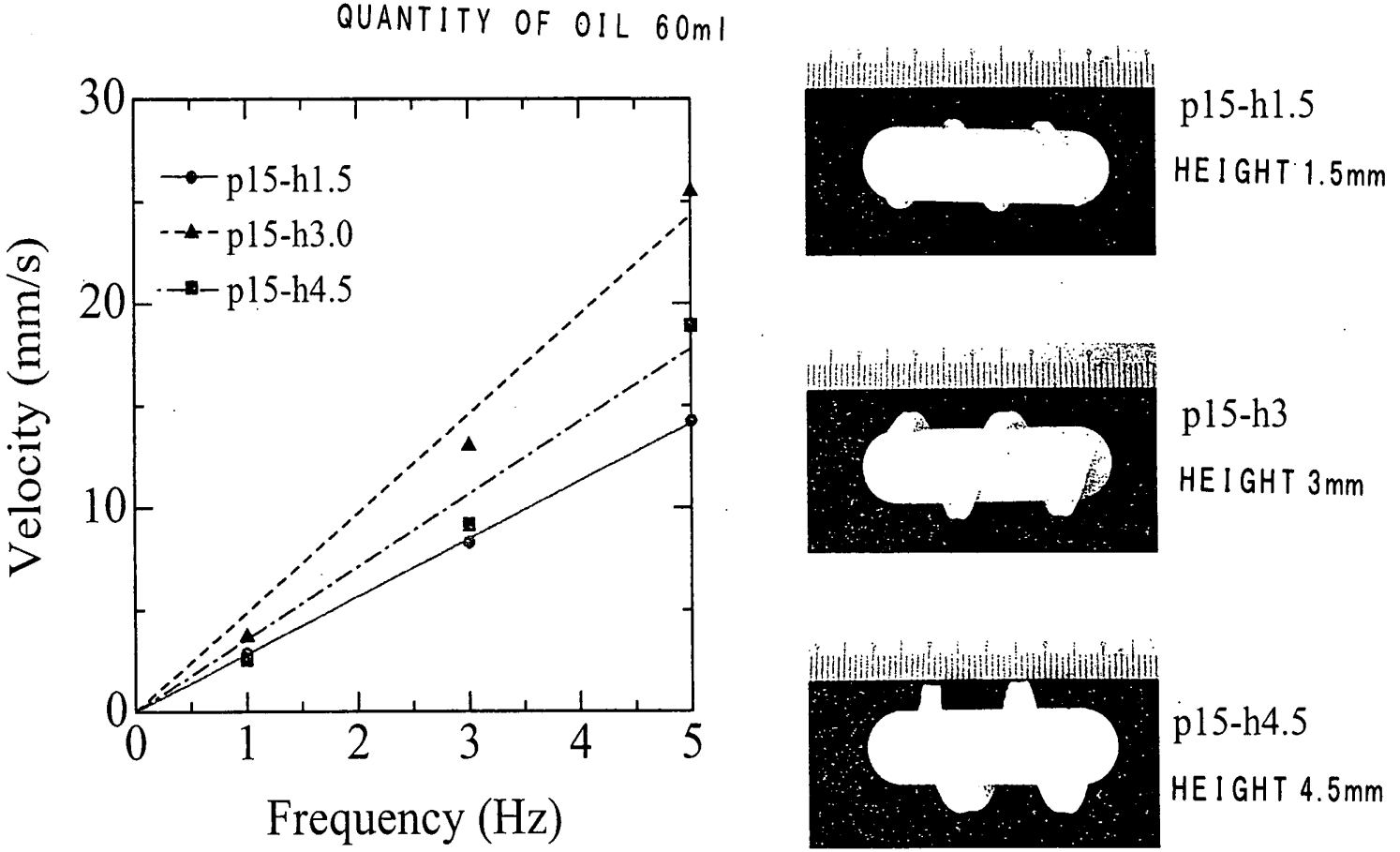
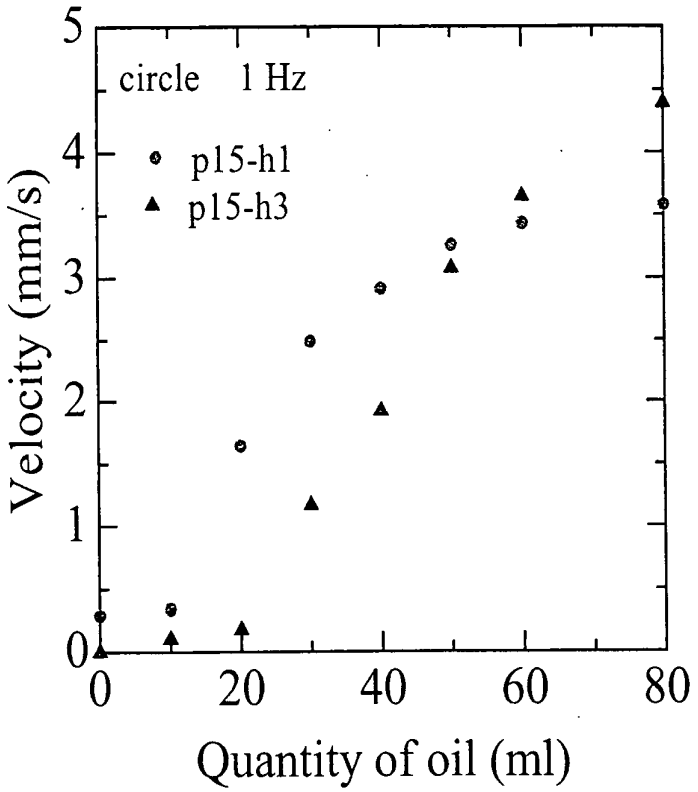
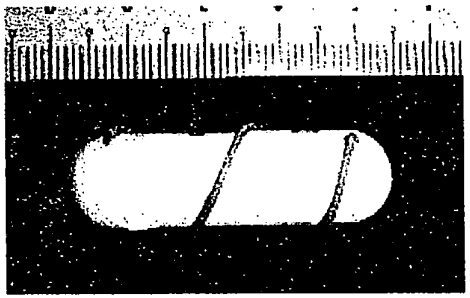


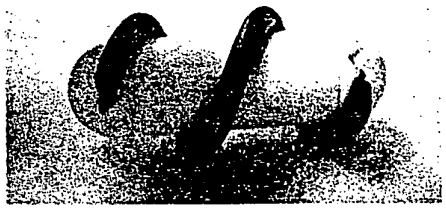
FIG.11

EXPERIMENT RESULT SPIRAL HEIGHT





p15-h1



p15-h3

EXPERIMENT RESULT SPIRAL CROSS-SECTION

p15-h3

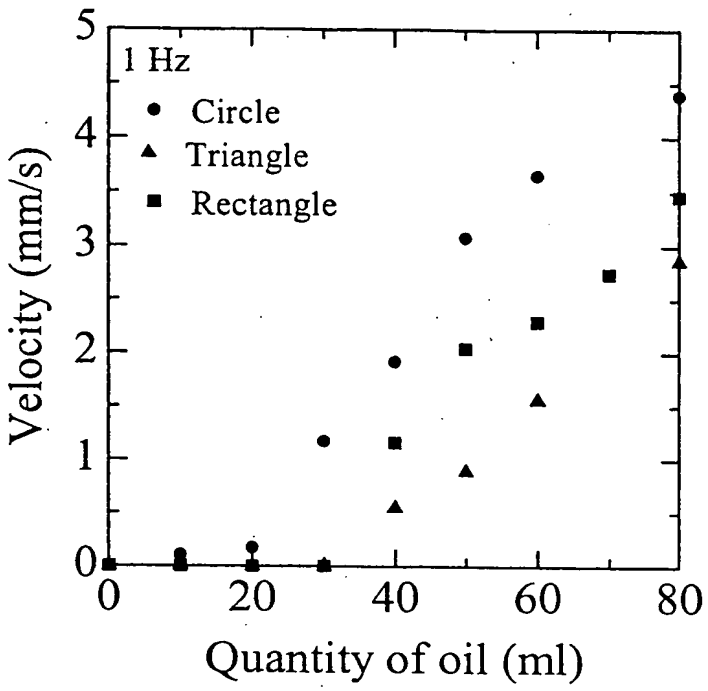


FIG.12

EXPERIMENT RESULT SPIRAL EDGE SHAPE

p15-h3, circle

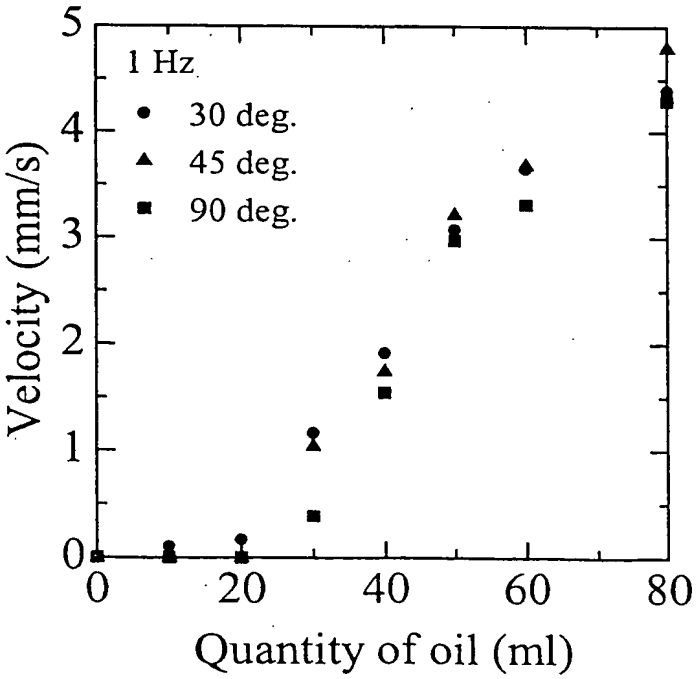


FIG.13

FIG.14

EXPERIMENT RESULT NUMBER OF SPIRAL

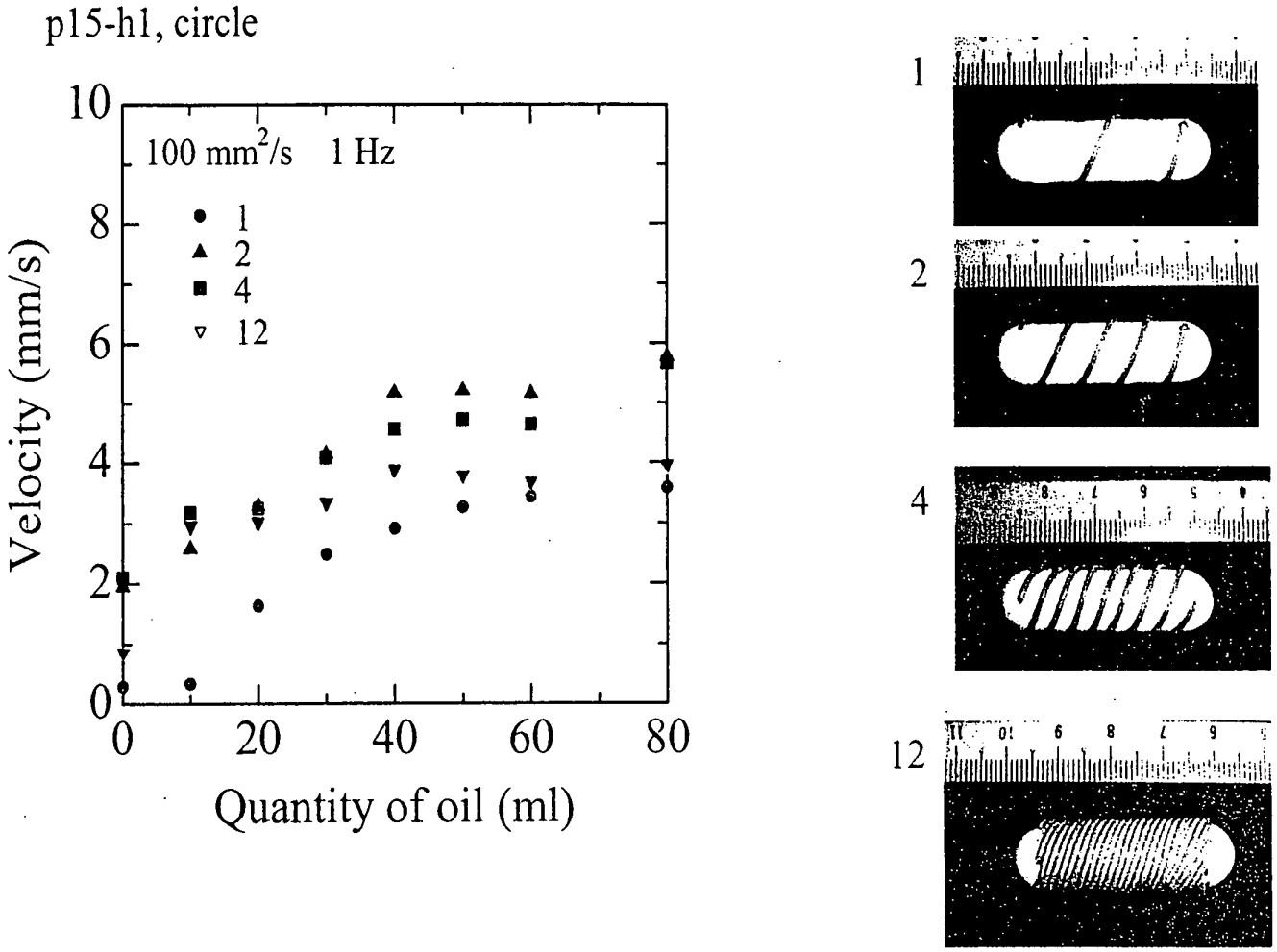


FIG.15A

NUMBER OF TIMES OF ROTATING DEFECT				SPIRAL SHAPE	
TYPE	1Hz	3Hz	5Hz	SPIRAL HEIGHT	SPIRAL PITCH
a	0	0	0	1.5 mm	5 mm
b	0	0	0	1.5 mm	10 mm
c	0	0	0	1.5 mm	15 mm
d	0	0	1	3 mm	5 mm
e	0	0	3	3 mm	10 mm
f	0	1	2	3 mm	15 mm
g	0	3	5	4.5 mm	5 mm
h	0	4	5	4.5 mm	10 mm
i	0	4	5	4.5 mm	15 mm

FIG.15B

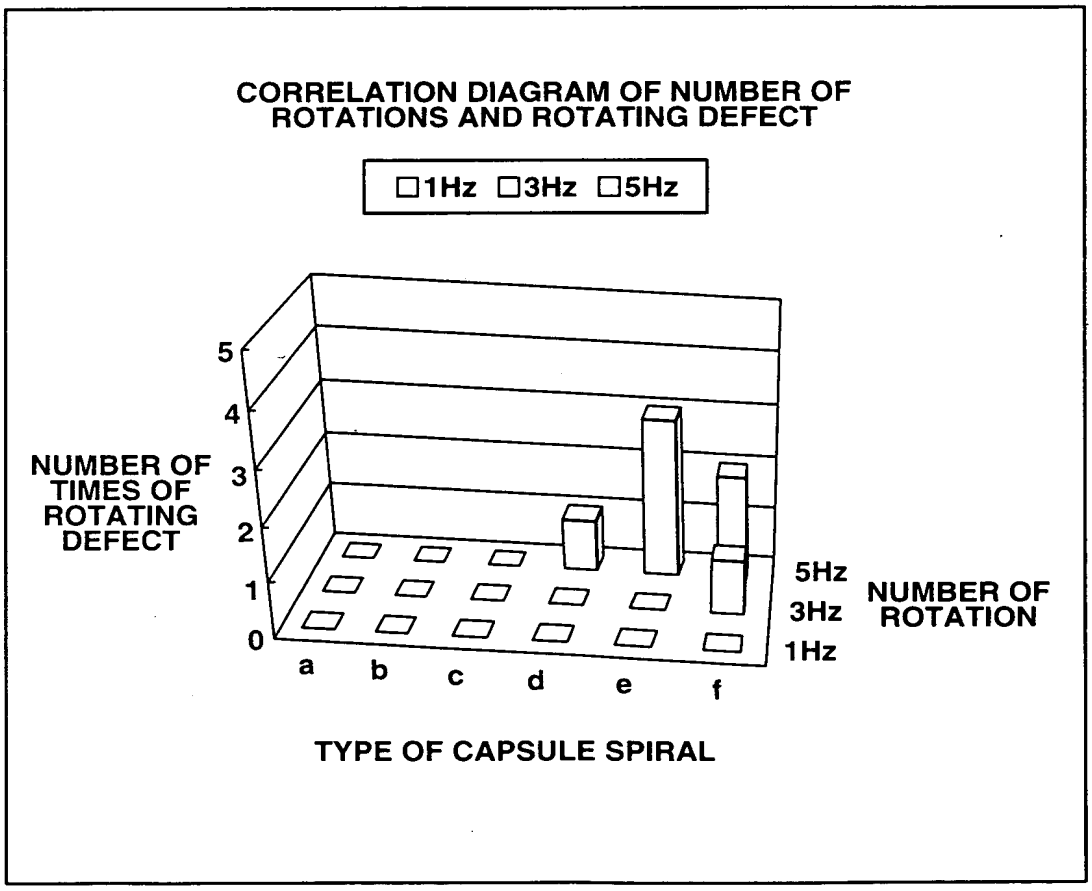


FIG.16

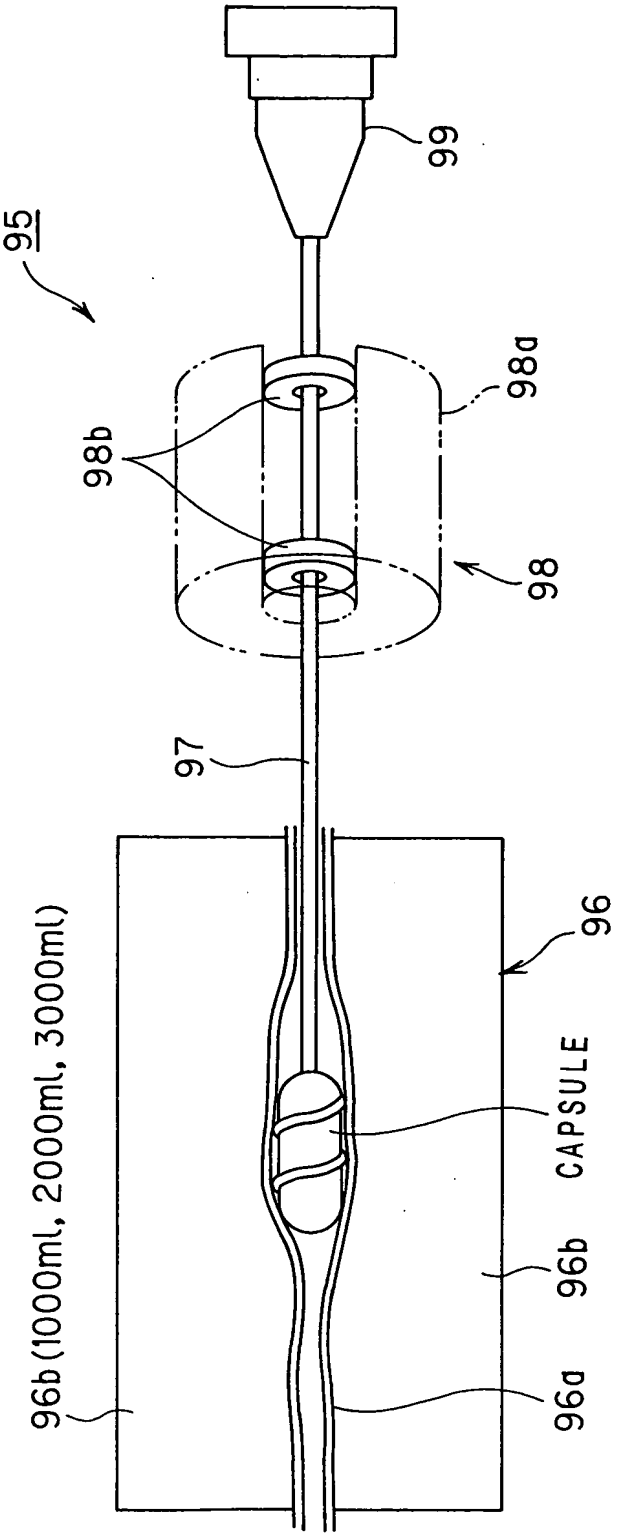

95
99
98a
98b
98
97
96
96b (1000ml, 2000ml, 3000ml)
CAPSULE
96b
96a

FIG.17A

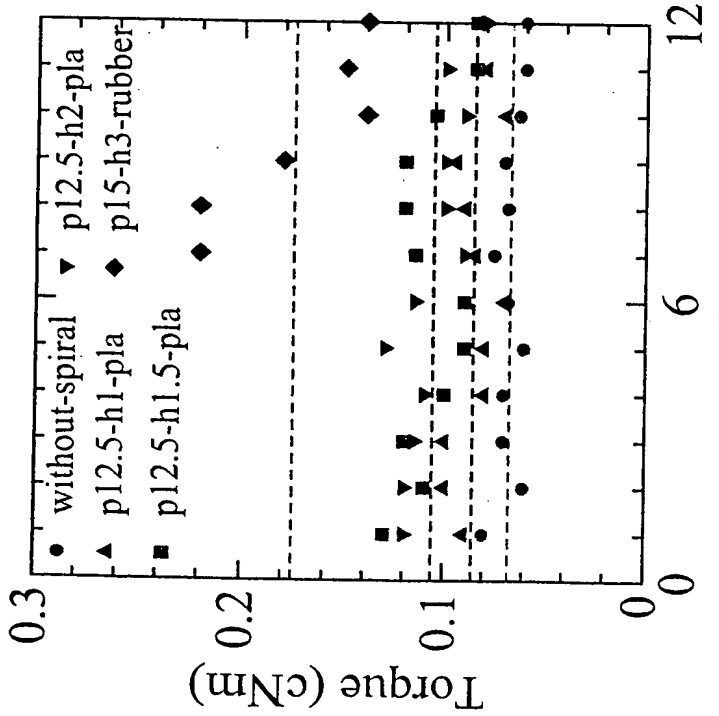


FIG.17B

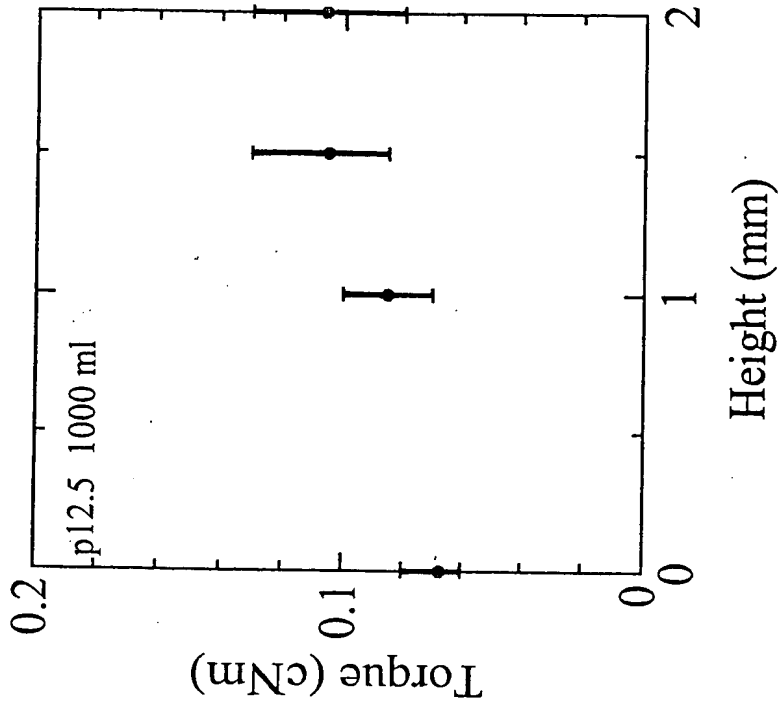


FIG.18A

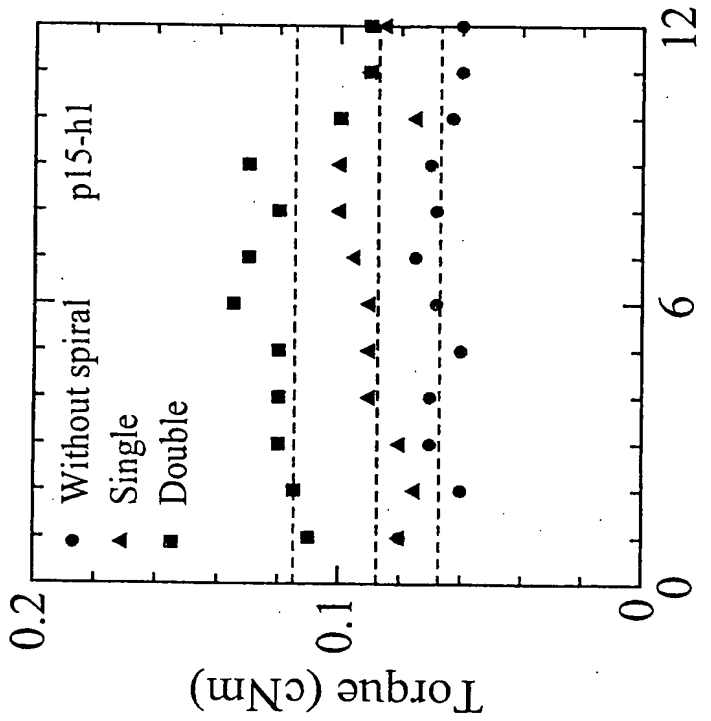


FIG.18B

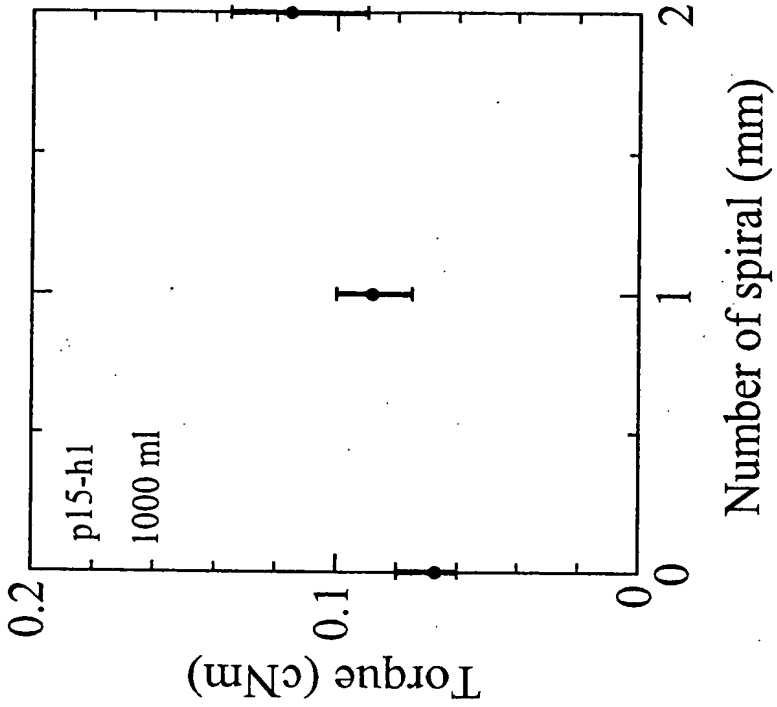


FIG.19A

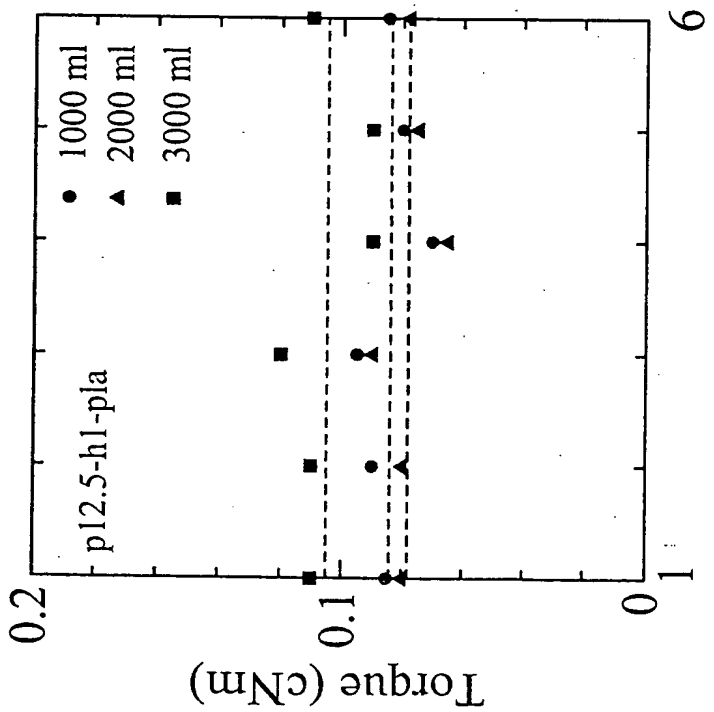


FIG.19B

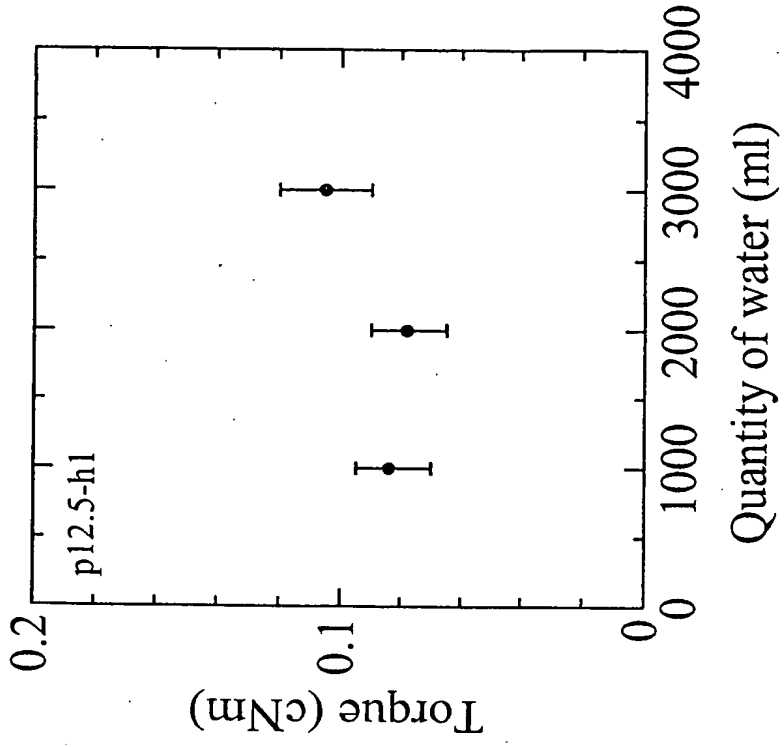
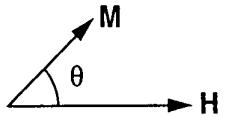


FIG.20

MAGNETIC TORQUE T

$T=M \quad H$

$T=MH\sin\theta$



MAXIMUM TORQUE AT θ OF 90°

MAGNETIC MOMENT M (Wb-m)= RESIDUAL MAGNETIC-FLUX DENSITY (T) × MAGNET VOLUME (m^3)

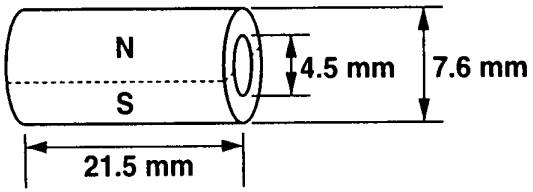
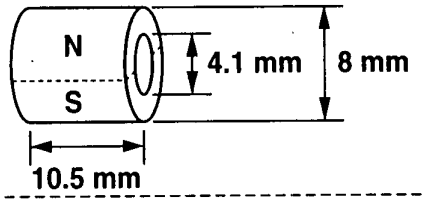
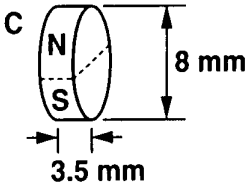
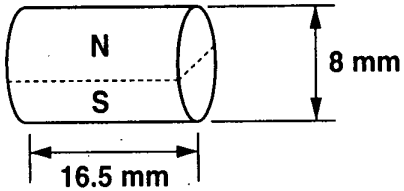
		RESIDUAL MAGNETIC-FLUX DENSITY	VOLUME	MAGNETIC TORQUE (UPON APPLYING MAGNETIC FIELD OF 150 Oe=12kA/m)
A		1T	633 mm^2	0.76 cNm
	p15-h1-double 30-40 Oe APPROXIMATELY 0.15Nm			
B		1T	389 mm^2	0.47 cNm
	p12.5-h1-pla 50-60 Oe APPROXIMATELY 0.15Nm			
C		1T	176 mm^2	0.21 cNm
D		1T	829 mm^2	1 cNm

FIG.21A

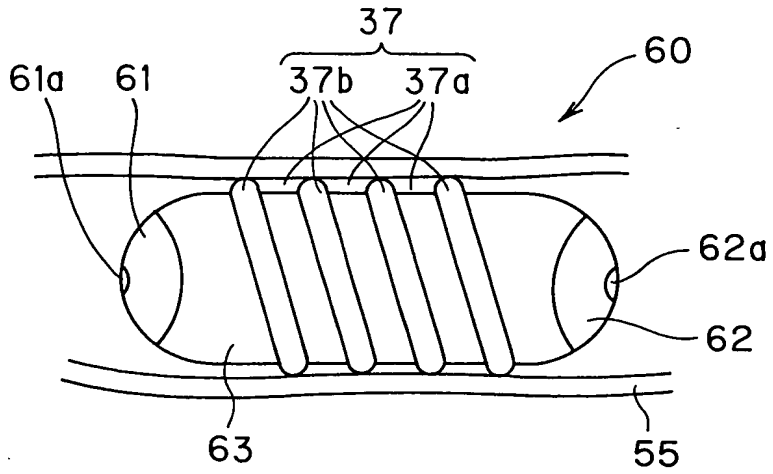


FIG.21B

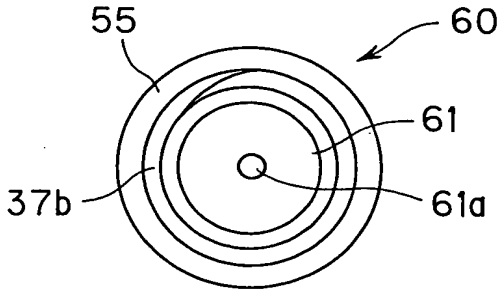


FIG.22A

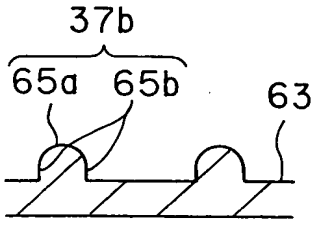


FIG.22B

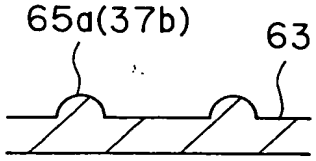


FIG.22C

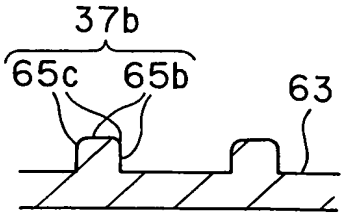


FIG.22D

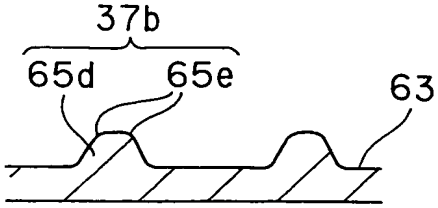


FIG.23A

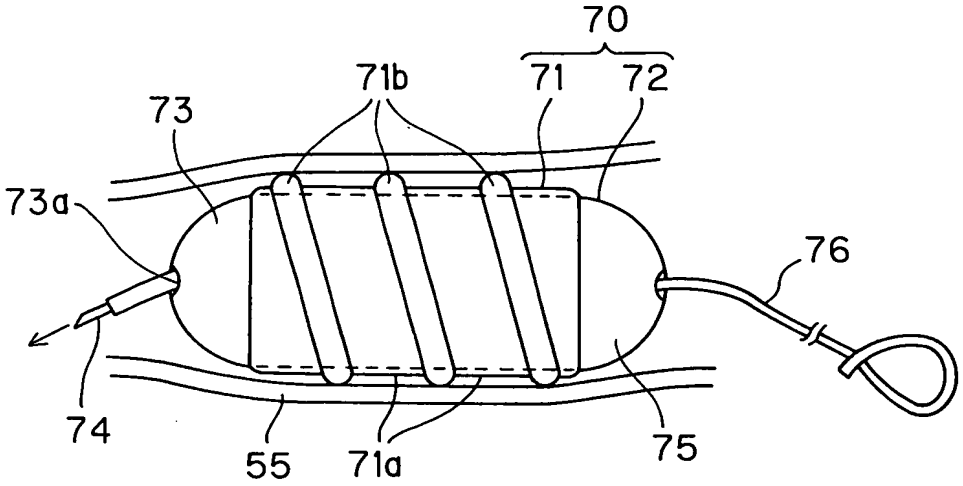


FIG.23B

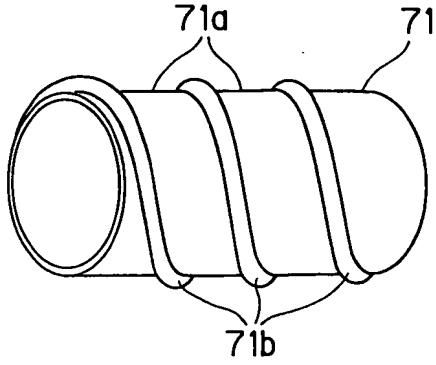


FIG.26

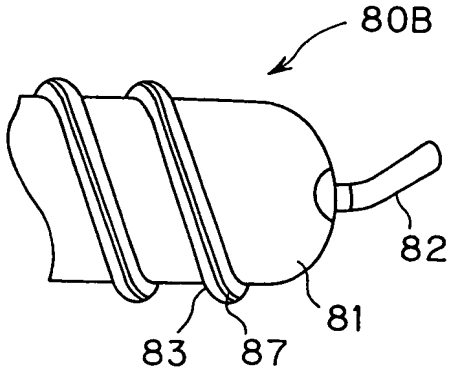


FIG.27

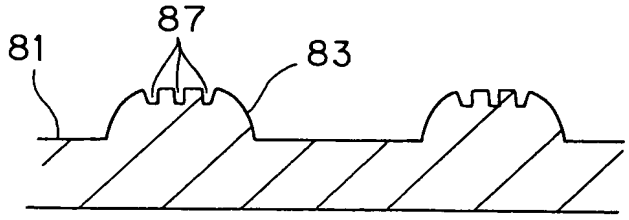


FIG.24

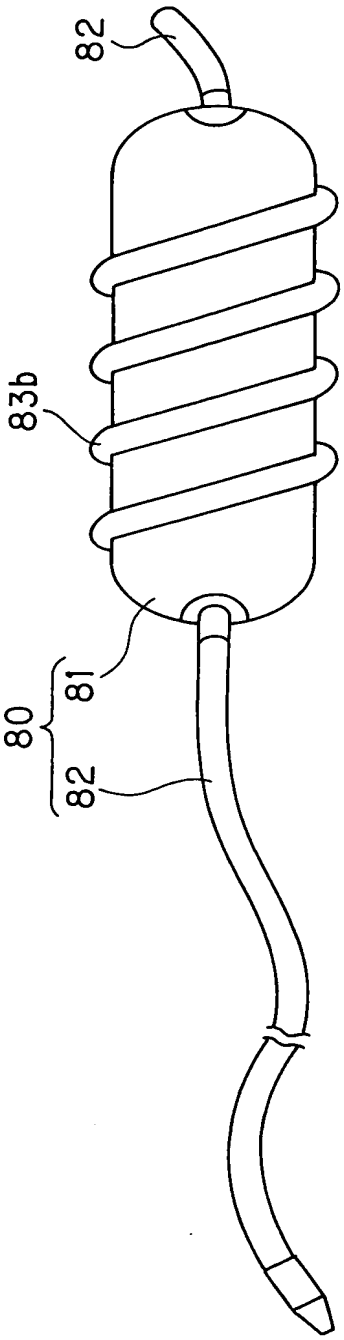


FIG.25